three, and abstracts of 12. Abstracts of the most interesting discussions are included. The following nine are mentioned here by title only, for the reasons given:

Progress of American Meteorology in 1919. By C. F. Brooks. [The contributions in the REVIEW for the past 12 issues tell the story of this progress. This paper was founded on an article, "Meteorology and Climatology," in the American Year Book, 1919.]

How the American Meteorological Society can serve geography teachers. By C. F. Brooks. [Of limited interest.]

Aims and achievements of the Blue Hill Observatory. By Alexander McAdie. [To be published in full elsewhere. Not easily subject to abstracting.]

Plans for establishing a network of meteorological stations in Palestine. By P. W. Etkes, New York. [Simply a statement of plans.]

Sunshine in the United States. By R. DeC. Ward. [Published in the Nov. 1919, REVIEW, p. 794–795.]

Explanation of peculiarities of flying in the wind. By J. G. Coffin. [Published in Aviation, New York, Dec. 1, 1919, vol. 7, pp. 383–385.]

The following three are to be published in extended form in later issues of the REVIEW:

Use of laws in teaching climatology. By S. S. Visher.

Preliminary steps in making free-air pressure and wind charts. By C. L. Meisinger.

Clouds and their significance. By C. F. Brooks.

A BUNDLE OF METEOROLOGICAL PARADOXES.

By W. J. HUMPHREYS.

[Excerpts from presidential address, Washington Philosophical Society, Jan. 31, 1920; also, presented in part before American Meteorological Society, St. Louis, Mo., Dec. 30, 1919.]

The scientific paradox is only an exception to some familiar but too inclusive generalization. It therefore has both the appeal of the riddle and the charm of surprise—the suprise, the instant the truth is seen, of a sudden and unexpected discovery.

1. **Air pushed north blows east** (due to the deflective effect of the earth's rotation).

2. **Rain dries the air** (since rain is formed from water vapor previously existing in the air).

3. ***More air goes up than ever comes down.***

As everyone knows, the vertical circulation of the atmosphere is only a gravitational phenomenon consisting of the sinking of relatively cold, and, therefore, also relatively dense air, and its consequent *lifting* or *forcing* up of adjacent air that happens to be comparatively warm and light. In short, contracted air descends and expanded air ascends (is buoyed up by the descending denser air). Hence, mass for mass, the *volume* of the ascending air is always larger than that of the descending air. The ratio between the actual ascending and descending volumes, however, or masses, may be anything, as illustrated by chimney circulation, in which the ascent is restricted to a comparatively small volume and mass moving rapidly, while the descend extends to a relatively large volume and mass settling slowly. On the average, though, considering both velocity of vertical movement and volume occupied, or velocity times volume, the atmosphere as a whole is always ascending, a fact not only interesting itself but also of some importance to both the aeronaut and the aviator.

Whatever the volume relations between ascending and descending air may be, it would seem that at least the mass that goes up and the mass that eventually returns must certainly be the same. But, on the contrary, they indeed are far from it, for one of the important constituents of the atmosphere, water vapor, often amounting, in places, to 1 per cent, and occasionally to more than 2 per cent of the whole, invariably ascends as a gas, as a distinct part and parcel of the air; but descends, in great measure, not as a gas at all, not as any part whatever of the air, but as a liquid in the form of rain, or a solid, such as snow and hail.

Paradoxical, therefore, as it may be, a greater mass of *air* actually does go up—more by at least 20,000,000 tons per second, the measure of world-wide precipitation—than ever comes down.

4. **To cool air, heat it; to warm air, cool it.** [Heated air rises and cools more than it was heated, and vice versa.]

5. **Not air that is heated, but air that is not heated, is thereby warmed; not air that is chilled, but air that is not chilled, is thereby cooled.** [Heated air rises and is replaced by other air which is dynamically heated in descent, and vice versa.]

6. **Mixing brings the air to a nonuniform temperature.** [When thoroughly mixed, the potential temperature of the air is the same; hence the temperature gradient is adiabatic and not isothermal.]

7. **The nearer the sun the colder the air.**

[The air grows colder with elevation—the nearer the sun the colder the air—because (1) owing to its transparency to solar radiation it is heated mainly at the surface of the earth, and (2) because, at ordinary temperatures, it emits more radiation than it absorbs. These together so affect the density of the atmosphere as to induce vertical convections, and thereby to establish and maintain, throughout the region in which they are active, a rapid decrease of temperature with increase of elevation.]

8. **The coldest air covers the warmest earth.** [Refers to the air in the stratosphere, which is coldest over the equator. The temperature of the stratosphere seems to depend upon radiation from below, and consequently upon the effective temperature of the earth's surface below; but the heavy cloudiness in equatorial regions makes the effective temperature of the surface there less than that at middle and high latitudes.]

9–10. **As the days grow longer the cold grows *stronger; as the nights grow longer the heat* grows stronger.** As the sun descends the temperature ascends. [Due to lag in heating and cooling the atmosphere.]

11. **The absolute maximum supply of heat in any consecutive 24 hours is not at the equator but at the south pole.** [As some one has remarked, "The sun shines day and night at the south pole." The south pole receives more insolation than the north pole, because the earth is nearest the sun when the south pole is best exposed to its rays. The altitude of the south polar region, the dryness of the air, and the lack of dust in the Antarctic atmosphere assist also.]

12. **The hotter the sun the colder the earth.** [Statistics show that at sun-spot maximum the earth is colder than at sun-spot minimum. At spot maxima there is less ozone produced in the upper atmosphere because the ultra-violet rays, which are the ozone-producing agents, are retained in the then dustier solar atmosphere. Hence at spot minima there will be more ozone in upper atmosphere of the earth. Ozone acts as a shield that decreases the radiation of heat from the earth, and thus keeps it warm, even though there is less total insolation.

13. **The sun rises before it is up; the sun sets after it is down** [due to the bending of the rays by refraction].